REMARKS

The Office Action mailed May 21, 2003 has been reviewed and the comments of the Patent and Trademark Office have been considered. Claims 1-16 were pending in the application. Claims 1, 5, and 13-16 have been amended and no claims have been canceled and new claim 17 has been added. Therefore claims 1-17 are pending in the application and are submitted for reconsideration.

This amendment changes and adds claims in this application. A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, is presented, with an appropriate defined status identifier.

Additionally, Applicant submits herewith certified translations of Japanese Patent Application Nos. 2001-048756 and 2001-381889 from which the present application claims priority.

§ 102 Rejections

In the Office Action, claims 1-16 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. patent 6,399,915 to Mori et al. (hereafter "Mori"). Applicants respectfully traverse these rejections for the following reasons.

As described and claimed herein, the present invention is directed to a laser weld quality monitoring method and system allowing for an ensured detection of occurrences of weld states such as a porous, under-filled, and non-welded, without an undesirable increase of burden imposed on a processing capacity of CPU.

As claimed in amended claim 1, the laser weld quality monitoring method comprises: "welding a part of work with a laser beam irradiated thereon from a YAG laser; detecting a varying intensity of light from the welding part to provide a detection signal; determining a value of signal power of a frequency spectrum in a specified frequency band of the detection signal, the specified frequency band having a specific relation with a porous state of the welding part; and making a decision for the porous state of the welding part to be significant as the value of signal power exceeds a threshold of weld quality, and to be insignificant as the value of signal power does not exceed the threshold of weld quality."

In the claimed invention, the specified frequency band is determined from the signal intensity calculated from the reflection of a laser beam from a welding part. Further, the

specified frequency band has a specific relation with a porous state of the welding part. With the claimed method, a porous state is easily detected based on the signal power of the specified frequency band. For example, when a Fourrier transform is applied to the signal intensity obtained from the reflection, a distribution of relative signal power is obtained. This distribution of relative signal power shows a significant difference between a conforming bead section and a porous bead section (see specification page 15, lines 12 to 25, Fig. 11).

More specifically, the power distribution of a conforming bead section has significant peaks of relative signal power within a frequency range of 100Hz to 500Hz, while that of a porous bead section has significant peaks of relative signal power within a frequency range of 0Hz to 1000Hz. This frequency range varies depending on the thickness of the work, the welding speed and the aspect ratio of a keyhole at the welding part. Thus, the specified frequency band may be determined on the basis of at least one of (1) a relation between the specified frequency band and the thickness of the work, (2) a relation between the specified frequency band and the welding speed, and (3) a relation between the specified frequency band and the aspect ratio of the keyhole at the welding part (see specification page 17, line 15 to page 19, line 35).

In claims 13 and 14, a value of signal power of a frequency spectrum in the specified frequency band of the detection signal is determined, so that the same effects can be achieved.

In claims 5, 15 and 16, a first frequency band, a second frequency band and a third frequency band are calculated as the specified frequency band, and further a mapping of a combination of calculated values of the first and second signal power sum is made, so that the same effects can be achieved.

In contrast with this, in Mori, the intensity of the plasma light and the intensity of a reflected light of the YAG laser are individually measured. Signal levels of both a low-frequency component (DC component, equal to or below approximately 100 Hz) and a high-frequency component (AC component, having a large time variation up to about 10 KHz) are respectively detected. Mori then notes that four kinds of information signals vary as a function of various welding parameters, e.g., the laser output, the focal point position, overlapped seam gap length, and so forth. Thus, the quality of welding at the weld is determined by monitoring the variation in the four kinds of signals. From these, an accurate

estimation of which parameter causes the failure in welding quality is derived. This can be used to eliminate the cause of failure in welding (column 2, lines 35 to 65).

Mori fails to disclose that a decision for a porous state of the welding state is made on the basis of the specified frequency band having a specific relation with the porous state of the welding state. Mori also fails to make a mapping of a combination of calculated values of the first and second signal power sums. Thus, Mori does not anticipate the claims of the instant application.

§ 103 Rejections

Claims 1-16 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. patent 5,961,859 to Chou et al. (hereafter "Chou"). Claims 1-16 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. patent 5,728,992 to Swidwa (hereafter "Swidwa"). Applicants respectfully traverse these rejections for the following reasons.

Chou shows a technology for monitoring the quality of a laser welding by monitoring the light emitted from the weld plasma. However, Chou fails to disclose or suggest a decision for a porous state of the welding state is made on the basis of the specified frequency band having a specific relation with the porous state of the welding state. Chou also fails to disclose or suggest a mapping of a combination of calculated values of the first and second signal power sums. Therefore, Chou does not render obvious the claims of the instant application.

Swidwa shows a method for a real time evaluation of laser welds in which the pulses of light from the weld site are compared with base pulses generated from a good weld to determine weld quality. However, Swidwa fails to disclose or suggest a decision for a porous state of the welding state is made on the basis of the specified frequency band having a specific relation with the porous state of the welding state. Swidwa also fails disclose or suggest a mapping of a combination of calculated values of the first and second signal power sums. Therefore, Swidwa does not render obvious the claims of the instant application.

Moreover, "porous state" (see Fig. 6, reference numeral 23) in the present application means the welding state in which small voids exist **inside** the welding part. That is, the small voids cannot be seen from the outside. In contrast, "void" and "blow hole" as disclosed in the cited references means the welding state in which voids can be seen from the outside. The

"porous state" in the welding part could not been monitored by the technology shown in the cited references. In contrast, this "porous state" can be monitored by the presently claimed invention in which a decision is made on the basis of the specified frequency band having a specific relation with a porous state of the welding part (claim 1), or in which a decision is made on the basis of the mapping of a combination of calculated values of the first and second signal power sums (claim 5).

Conclusion

As has been discussed previously, the Examiner's cited references does not disclose or suggest the claimed invention. Thus, the cited references neither anticipate nor render obvious the claims of the present application.

The dependent claims are also patentable for at least the same reasons as the respective independent claims on which they ultimately depend. In addition, they recite additional patentable features when considered as a whole.

In view of the foregoing, applicants respectfully submit that the application is in condition for allowance and an early notice to this effect is earnestly solicited. If there are any questions regarding the application or if an examiner's amendment or an interview would facilitate the allowance of one or more of the claims, the examiner is courteously invited to contact the undersigned attorney at the local number below.

Respectfully submitted,

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By _____

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